

## PROCEEDINGS OF OBSERVATORIES.

The following reports of the proceedings of observatories during the past year have been received from the directors of the several observatories, who are alone responsible for the same :—

*Royal Observatory, Greenwich.*

The past year has been an exceptionally heavy one in various ways, and has somewhat severely taxed the energies of the staff. Two new assistants were appointed in February to fill vacancies which had existed for some time; and the observatory was for some months without the services of a clerk. Important changes in the buildings have occupied much of the attention of the Astronomer Royal; and, finally, two important longitude operations have required nearly the whole time of Mr. Hollis during three quarters of the year, and a considerable portion of that of the Chief Assistant.

It might therefore be expected that the regular work would necessarily suffer to some extent; but it is reassuring to find that the arrears (chiefly in the printing) are not serious, and will probably be effaced early in 1893. The total number of transits observed in the year 1892 is 6,212, and of zenith-distances 5,607, which numbers compare favourably with those for any previous year. The total number of stars observed in 1892 was 1,722.

The reductions for the Five-year Catalogue of Fundamental Stars from observations in the years 1887–1891 are completed, and the Catalogue will be published as an appendix to the volume of Greenwich Observations for 1891. Meanwhile the resulting star-places have been communicated to the Superintendent of the *Nautical Almanac* and used by him in the *Nautical Almanac* for 1896 (just published).

The N.P.D.'s of the Ten-year Catalogue have been analysed by comparing the results for the separate years with the mean. The comparison suggested periodic fluctuations of latitude of the kind found by Mr. Chandler in his recent investigations; and on a more direct reduction of the Greenwich observations from 1851 to the present time being undertaken by Mr. Thackeray. Mr. Chandler's doubly periodic variation of the latitude (in about 365 and 427 days respectively) was very satisfactorily confirmed. The results have been given in two papers communicated to the Society by Mr. Thackeray (*Monthly Notices*, liii. pp. 2, 120).

The mean error in R.A. of Hansen's Lunar Tables, with Newcomb's corrections, as deduced from 111 observations with the Transit-Circle in 1892 is  $+0^{\circ}.069$ , agreeing well with the results for previous years since 1883.

Recent observations of horizontal flexure by means of the collimators show that the coefficient is still very small. The apparent correction to nadir observations deduced from reflection observations of stars is  $-0''.25$ , a rather large quantity. No correction for flexure, or for the above nadir discordance, has been applied to the observations apart from the R — D correction.

Observations with the altazimuth were intermitted during the months May to October, owing to the great pressure of other work. In the remaining months the Moon was observed regularly during the first and last quarters. The proposition to replace this instrument by a Universal Transit-Circle, as described by the Astronomer Royal (*Monthly Notices*, lii. p. 480), has been sanctioned by the Admiralty.

Five comets have been observed during 1892 with the Sheepshanks Equatoreal, viz.: Comet (a) 1892 (Swift) on fourteen nights; (c) 1892 (Winnecke) on one night; (d) 1892 (Brooks) on nine nights; (f) 1892 (Holmes) on nine nights, and (g) 1892 (Brooks) on three nights.

Twenty-five occultations of stars (including seven disappearances and three reappearances of stars during the lunar eclipse of 1892 May 23); the occultation of *Uranus* by the Moon on July 3; the occultation of 73 *Piscium* by *Jupiter* on May 23; and 49 phenomena of *Jupiter's* satellites, have been observed with the Equatoreals, by one or more observers.

With the Astro-photographic Equatoreal 489 plates, involving 1,222 exposures, have been taken during the past year. The total time of exposure, exclusive of trails for orientation, was  $127^h 8^m$ . Of the plates, 88 were Chart and 220 Catalogue plates, 67 were for instrumental adjustment, 75 of *Nova Aurigæ*, 13 of the *Pleiades*, 16 of various regions, and 10 were attempts at Chart plates cut short by clouds. The plates of *Nova Aurigæ* have been measured for determination of the magnitude of this star at different epochs, and the results have been communicated to the Society. Four of the miscellaneous plates were exposed on *Jupiter*, a concave enlarging lens (specially made by Dallmeyer) being used to magnify the image about 15 times. The photograph micrometer used for the measurement of Transit of *Venus* (1874) photographs has been modified for use with the stellar plates. The measures can be made quite independently of the *réseau*, which will be an advantage if this auxiliary has ultimately to be dispensed with, owing to the decomposition of the film, which it seems difficult to prevent. As regards the selection of guiding stars for the plates of the chart:—Since the date of the last report the remainder of the catalogue for zone  $+60^{\circ}$  to  $+65^{\circ}$  (Rome) has been sent to Father Denza; the

second 12 hours of R.A. of the zone  $+25^{\circ}$  to  $+29^{\circ}$  (Oxford) has been sent to Professor Pritchard; the catalogue for  $12^{\text{h}} - 18^{\text{h}}$  R.A. for the zone  $-3^{\circ}$  to  $-5^{\circ}$  (San Fernando) has been completed, and the approximate star-places for R.A.  $0^{\text{h}} - 12^{\text{h}}$  and R.A.  $18^{\text{h}} - 24^{\text{h}}$  have been communicated to Dr. Becker, of Strassburg, who is determining accurate places by meridian observation.

The  $12\frac{3}{4}$ -inch Merz refractor, dismantled in 1891 November to make room for the new 28-inch refractor, was mounted in place of the Lassell reflector on 1892 April 13, the Thompson photo-heliograph being attached to the tube. In its present position, however, it cannot be effectively used owing to the interference of the new building of the proposed Physical Observatory, on the central tower of which it will, as is hoped, soon be mounted, together with the Lassell dome. The old south-east dome was dismantled in November, and operations for the erection of the new 36-foot dome which is to cover the 28-inch refractor, were commenced by Messrs. T. Cooke & Sons in the middle of December. No spectroscopic observations have been made during the year.

Photographs of the Sun have been taken with the Dallmeyer 4-inch photo-heliograph on 210 days, and of these 518 have been selected for preservation, including 29 photographs with a double image of the Sun, taken to determine the position of the wires with reference to the parallel of declination.

For the first three months of the year the Dallmeyer photo-heliograph was mounted on the first floor of the new museum, from which it was removed on April 6 to its old position in the wooden dome south of the Photographic offices. Here it remained during the summer months until the Sun was no longer sufficiently high to be observed over the roof of the new museum building, and on September 9 the photo-heliograph was once again transferred to the new museum.

Photographs of the Sun have also been taken with the Thompson photo-heliograph on 35 days during the year. A new enlarging lens has lately been supplied for this instrument by Messrs. Ross & Co., with very satisfactory results as regards flatness of field and freedom from distortion. Photographs have also been received from India and Mauritius up to December 6, leaving seven days in the year ending on that day for which no photograph is yet available for measurement.

The increase in the solar activity which was so marked in 1891 has continued during 1892. The Sun has not been free from spots on a single day; as many as ten or eleven distinct groups have often been seen on the disc at the same time. Several of the groups observed have been of very great size and complexity, and one (that of Feb. 5-18) was by far the largest ever photographed at the observatory. It is premature yet to decide whether the actual maximum has been attained, but the great increase in the number of the spots appears to point to its being near at hand.

The operations for determining the longitude of Montreal were successfully concluded in September. In the spring (April and May) two series of observations were completed, the observers at Greenwich and Waterville (Ireland), and at Montreal and Canso (Nova Scotia), being interchanged between the two series, but no exchange of observers being made across the Atlantic. For the autumn operations Professor McLeod, of Montreal, came to England, and Mr. Turner crossed to Canada, and interchanges of observers were made as in the spring, between the pairs of stations separated by the cable.

The following table shows the number of nights of observation at the several stations in the four parts.

Part.	Greenwich.		Waterville.		Canso.		Montreal.	
	Full Nights.	Half Nights.	Full Nights.	Half Nights.	Full Nights.	Half Nights.	Full Nights.	Half Nights.
I.	5	2	3	2	6	...	3	1
II.	6	...	5	2	3	...	2	3
III.	8	4	4	3	4	3	6	3
IV.	7	3	2	4	10	1	5	1

Signals were exchanged on each night between Greenwich and Waterville, between Waterville and Canso (the cable termini), and between Canso and Montreal. A few experimental signals were exchanged between Greenwich and Montreal, being automatically registered and repeated at the intermediate stations, but the results were not so satisfactory as those of the signalling independently in sections. Discussion shows that the transatlantic signals are practically as good as those over short land lines, excepting that the time of transmission is greater, and hence there is a larger chance of error from the necessary assumption of equality in the time of transmission in opposite directions.

The reductions are so far advanced as to show that the determinations in the spring and autumn for Waterville are accordant *inter se*, and agree with the geodetic determination within  $2''$ , i.e. well within the limits of error due to local attraction. The results for the transatlantic stations are also so far satisfactory, judged by the standard of accordance *inter se*.

The longitude of Paris was also redetermined in June and July (in the interval between the two series for Montreal), in concert with the officers of the French Service Géographique. Observations were made at Greenwich on seventeen, and at Paris on twenty nights. The reductions are not yet sufficiently advanced to pronounce definitely on the subject of the discordance found in 1888.

While in England, Commandant Defforges took the opportunity of swinging his pendulums at this observatory, and at Leith Fort, Edinburgh, where Captain Kater had made observations. Thus the French pendulum observations will be connected with the English and Indian.

The building of the south wing of the Physical Observatory was commenced in November last, and this addition will, to some extent, relieve the observatory of the present great pressure on available space; but the relief will not be by any means complete until the whole of the proposed cruciform building is finished.

The electric-light installation has been sanctioned by the Admiralty, and the details of the scheme are practically settled.

The volume of Greenwich observations for 1890 was passed for press in August last, and is being distributed. The volume for 1891, as was remarked earlier in this report, is not so well advanced as usual, but it is hoped soon to make good this deficiency.

In February, Captain Grant, R.E., of the Ordnance Survey, consulted the Astronomer Royal as to the determination of the boundary of Mashonaland, in concert with Portuguese officers. The most difficult part of this operation was the fixing of a meridian of longitude on the spot, and without, of course, any possibility of telegraphic communication. The method of Moon culminations, observed with a small transit, was recommended; and a rough prediction of the Moon's errors was made for Captain Grant's use. A comparison of the prediction with observations since made is given in the *Monthly Notices*, vol. liii. p. 11.

Captain Viniegra, director of the San Fernando Observatory, paid a visit to Greenwich on April 4, and discussed the work of the Astro-photographic Chart.

Sir G. B. Airy, late Astronomer Royal, who died early in the past year, gave another proof of his attachment to the Royal Observatory by bequeathing to it such of his books, manuscripts, &c., as might be considered useful; and Mr. Wilfrid Airy has accordingly transferred to our library 94 volumes, 134 unbound tracts, and the voluminous manuscript calculations of the Numerical Lunar Theory.

#### *Royal Observatory, Edinburgh.*

The contract for the buildings of the new Royal Observatory was signed on 1892 May 25, the work being entrusted to Messrs. W. and J. Kirkwood, of this city. The plans were prepared by Mr. W. Wybrow Robertson, of H.M. Office of Works. A short description of them will be useful in following the progress of the work already done.

The main building extends 180 feet from east to west, terminating in two towers surmounted by domes, or rather "drums." The eastern tower, rising to a height of 75 feet, will contain the 15-inch Grubb refractor, while the 24-inch reflector from Calton Hill will be mounted in the western dome, the top of which will be some 44 feet above the ground at that end. A single range of rooms, opening on a corridor on the south, extends from tower

to tower, only the end rooms occupying the whole depth of the building. The roof is designed as an asphalted platform, 113 feet long and 22 feet broad, affording free communication between the towers. Beginning from the west, the apartments are thus arranged: Spectroscope room, general laboratory (with three isolated piers), electrical room, cleaning room, mechanics' workshop, chronograph and class room. Light and dark photographic rooms, as well as a computing room for the equatorial and photographic work, are situated in the eastern dome. Several useful basement rooms adjoining the large tower have been constructed.

A central extension of the main building towards the south, measuring some 80 feet by nearly 24 feet, will contain the chief computing room, the hall, stairs, and ante-room, the director's room, and, lastly, the fireproof library—a lofty apartment 34 feet 6 inches by 23 feet 9 inches, with a light iron gallery affording access to the upper shelves. There is a top storey to the southern part of this portion of the building 66 feet in length, designed for optical work, into which a large beam of light can be reflected from a siderostat on the flat roof to the north. An iron railway down the centre of the room, insulated from the rest of the floor, will support the instruments. It will be seen that this room practically forms a horizontal telescope.

In the basement will be placed the heating apparatus, a dynamo and accumulators for supplying electricity for lighting the observatory and illuminating the instruments. In the observatory there will thus be only one chimney, the draught of which can be controlled when requisite.

The transit circle will be housed in a separate building eighty feet to the west of the western tower, accessible by a covered way. By means of light walls and roof of corrugated iron, shaded by louvres of tinned steel, it is hoped that uniformity of inside and outside temperature may be secured. As an extra precaution against the egress of warmer air immediately over the instrument, the opening in the roof will be at a lower level than the air-outlets in the eastern and western sections of the roof.

The remaining buildings are the astronomer's house, two assistants' houses, arranged as a double villa, and a gate-lodge.

Owing to the steepness of the approach, and partly also to the position of the site in a public park which rendered it undesirable to cut up the roadway, an inclined railway was made from a temporary siding at Blackford Hill Station on the Suburban Railway. At the siding are also the sheds at which the greater part of the stone cutting is done. Hence little dead weight beyond the prepared materials has to be hauled up the hill. The siding and inclined track were finished by the middle of August. Meanwhile the rock excavations for the library and other parts of the buildings had been in progress since July 11, so that the first stone could be laid on the concrete bedding on

October 4. By the end of the year the whole of the main building with its east and west towers was well in progress. The walls are built of grey sandstone, from Hailes Quarry, to the west of Edinburgh, but are faced with a reddish freestone procured from Doddington Hill, in Northumberland.

Including the cost of drainage, water-pipes, pumping-chamber, and fencing, the expenditure at the close of the year was a little over 4,000*l*. Greater progress would have been made but for the severe frosts, which not only stopped all building, but also cut off the supplies of stone from the quarries.

At Calton Hill, Mr. Heath has carried on the time service, the meteorological reductions, and the preparation of weather-returns for the Registrar-General for Scotland, as in previous years. The revision of the Edinburgh star places has also been carried a stage further. A redetermination of the latitude with the mural circle is also in progress.

In July, Lieutenant Gratzl, of the Austrian Navy, observed the times of vibration of a pair of invariable pendulums at Calton Hill, preparatory to a visit to Jan Mayen, where the observations were to be repeated.

Fifteen astronomical circulars have been issued in the course of the year. The thanks of observers are due to Messrs. Berberich, Schorr, H. Oppenheim, and Archenhold, for their important contributions to these circulars. No. 22 is specially interesting, as containing the earliest notice of the outbreak of *Nova Aurigæ*. It is almost superfluous to add that this wonderful object was first seen by Dr. T. D. Anderson, of this city, who also independently picked up Comet Holmes two nights after its discovery in London. The *Nova* was observed on every favourable occasion until its disappearance, not only at Calton Hill, but also at Dunecht, by Dr. L. Becker, who went there the moment the star's extraordinary character was perceived. The results of these observations are published in the *Transactions of the Royal Society of Edinburgh* (vol. xxxvii., p. 51). On its re-appearance in the autumn, the star was again studied with the Dunecht refractor by Professor Copeland, with the valuable aid of Mr. J. G. Lohse, who was staying there for a short time. A later attempt made by Dr. Becker to secure a photograph of the spectrum was unsuccessful, owing, probably, to a want of sufficient clear sky for a lengthy exposure, for the same apparatus yielded a spectrum of *Jupiter*, full of minute detail.

In November and December Dr. Becker completely dismounted and packed the transit circle, together with the piers and collimators. The granite-work of these piers and their foundations is very beautiful and solid, and will be used again at Blackford Hill. The task of separating these massive cut stones was much lightened by the aid of the experienced and skilled mason, Mr. John Smith, who had erected them twenty years ago, and who, it is hoped, will rebuild them in their new quarters.

In continuation of his published work on the Low Sun Spectrum, Dr. Becker has reduced the late M. Thollon's Solar Spectrum to Rowland's wave-lengths and compared them with his own results. He has also revised the papers on *Nebulae* and on *The Latitude of Dunecht*, mentioned in last year's report.

Shortly after the new year, Dr. Becker was appointed successor to the late Dr. Grant in the Chair of Astronomy in Glasgow.

Just before daybreak on the morning of March 8, fire broke out in the official residence of the Astronomer Royal for Scotland. When it was first perceived, one corner of the house was already burning fiercely, from foundation to roof—five stories in all. Happily the inmates escaped unharmed. Notwithstanding the promptest exertions on the part of the police and the fire-brigade, the corner where the fire broke out, the whole of the roof, and the top flat were destroyed by fire, while much injury was inevitably done to the rest of the house by water. Fortunately the library was not materially damaged, though for months the books required continual turning over to prevent the inroads of mildew. The most valuable works entirely escaped injury, owing to their position in well-glazed cases in another part of the house. Practically ten months were required before the house and library were again in order.

By an oversight, wrong figures were given for the latitude of the new observatory on p. 190 of *Monthly Notices*, vol. 1. The approximate latitude is  $55^{\circ} 55' 28''.0$ .

#### *Royal Observatory, Cape of Good Hope.*

The inadequacy of the computing force for the past ten years has led to large and growing arrears of reduction which no effort on the part of the existing staff could overtake. The Lords Commissioners of the Admiralty having granted an addition to the computing staff, it appeared to H.M. Astronomer that the time had arrived to make a supreme effort to overtake these arrears. Accordingly, all meridian-observing not absolutely required has been suspended during the year; the assistants have thus been enabled to give much additional time to the work of reduction, and, as will be afterwards evident, a great amount of the arrears has been overtaken, although not so much as would have been but for the serious illness of two of the assistants.

The series of meridian observations of the Sun, *Mercury*, and *Venus*, with the brighter clock-stars, was continued until September 21, when it was interrupted by necessary repairs to the floor of the Transit Room and Central Hall. On removing the old flooring-boards of the Transit Room, it was found that the framework of beams supporting the floor, and even the strong wooden pillars which supported the roof, rested on the foundation of the transit circle piers. This explained the great difficulty which

had often been experienced in getting sufficiently steady images in reflex and nadir observations. Complete reconstruction of the framework of the floor and support of the roof became necessary—a work that was at once undertaken by, and is still in the hands of, the Director of Works Department.

The observations secured with the transit circle have been :—

				R.A.	N.P.D.
Observations of the Sun (both limbs)	...	...	...	77	74
„ Mercury	...	...	...	39	37
„ Venus	...	...	...	48	49
„ Azimuth stars	...	...	...	82	...
„ other stars	...	...	...	789	509
				1035	669
No. of determinations of Collimation	...	...	...	43	
„ „ Level	...	...	...	247	
„ „ Run	...	...	...	2°0	
„ „ Flexure	...	...	...	35	
„ „ Nadir	...	...	...	280	

Besides these, meridian observations of the Declination of Mars and the comparison stars of the Washington Programme were obtained on forty-four nights.

The weather, during the year, has been the most unfavourable for observing ever known at the Cape. The rainfall at the observatory was 40·9 inches, as compared with the average (for the past fifty-one years), 25·8 inches; but this proportion in no way expresses the much greater relative proportion of cloudy weather. Icebergs have been reported within sixty miles of Cape Point, and an unusual number of whales have entered False Bay and Table Bay. These facts probably point to an abnormal northward set of Antarctic currents; and hence, perhaps, the unusually damp and cloudy weather which has been experienced.

The following occultations of stars by the Moon were observed :—

Disappearances at dark limb	...	...	...	9
Reappearances „	...	...	...	4
				13

With the heliometer, observations for the parallax of six stars were made on twenty-four nights; forty observations of position-angle and distance of stars occulted by the Moon on 1891 November 15 were also made. In accordance with Dr. Lohse's request, forty-five observations of the position-angle of the polar-spot on *Mars* were made near the time of opposition.

The zenith telescope has been employed by Dr. Gill in an

investigation on the Constant of Aberration and Change of Latitude; 574 observations were secured by him.

Comet *a* 1892 (Swift) was observed on fourteen nights.

The damp and cloudy weather has been especially unfavourable for photographic work. Many preliminary experiments had to be made before all practical details connected with the plans of the Astrophotographic Congress could be satisfactorily worked out. Regular work was begun on July 26, and so unfavourable has been the weather that only "catalogue" plates have as yet been attempted. Of these have been obtained :—

Successful plates	...	...	...	307
Rejected	...	...	...	58
Standard areas	...	...	...	35
Total				400 = 1200 exposures.

The following miscellaneous photographs were taken, chiefly previous to July 26, when regular astrophotographic charting commenced :—

	Plates.	Exposures.
Adjustments, screen experiments, &c.	50	211
Stars occulted by Moon 1891 November 15	26	52
$\eta$ Argûs	13	13 (5 <sup>s</sup> to 12 <sup>h</sup> )
$\alpha$ Centauri (as a double star)	5	136
$\omega$ Centauri (cluster)	3	3 (14 <sup>m</sup> , 1 <sup>h</sup> 53 <sup>m</sup> , 3 <sup>h</sup> )
$\kappa$ Crucis (cluster)	1	1 (35 <sup>m</sup> )
Lunar eclipse 1892 May 11	10	10
Plates for stellar parallax	16	85
Comparison of areas in various galactic latitudes	12	15
Total	136	526

Much labour has been given to experimental work in measuring plates and reducing the measures, determining *réseau* errors, &c., but it has become necessary to suspend all such work for the present, until other arrears are overtaken.

The state of the reductions of the meridian observations is as follows: The Cape General Catalogue for 1885, the Annual Meridian Volumes for 1885, 1886, and 1887 are ready for press, and the volumes for 1888 and 1889 are being copied for press. The observations made in 1890 are completely reduced and examined to "apparent place," and the "mean places" are computed and partly examined. For 1891 the computation and examination are complete to "apparent place"; the duplicate copy of the corrections to reduce to mean place has to be computed and the corrections applied. For 1892 the R.A. is completely reduced and examined to April 17, and the N.P.D. to the end of the year.

With respect to the extra-meridian observations, the chief labour of reduction has been connected with the discussion of the observations made in 1889 and 1890 in carrying out the proposals of H.M. Astronomer for observing the minor planets *Victoria* and *Sappho*. The preliminary part of this work (the discussion of the heliometer triangulation of the comparison stars) was completed early in the year, and a short outline of the results of the work is published in the *Ast. Nach.*, No. 3107.

The discussion of the observations of *Victoria* is now nearly complete, and will be quite so (so far as the Solar Parallax is concerned) before this report is in the hands of the Society.

The comparison of the observations with the ephemeris has apparently demonstrated with great weight that Le Verrier's value of the constant of the Lunar Equation must be diminished about  $\frac{1}{60}$  part, and that, with the resulting value of the Solar Parallax, the accepted value of the Moon's mass must be diminished by more than one per cent. The amount of the correction to the Lunar Equation comes out nearly the same from each of the three lunations over which the observations extend, and from the Declinations as well as the Right Ascensions; although, of course, with much lower weight from the Declinations than the Right Ascensions.\* These results depend upon heliometer observations made at the Cape, Yale, Leipzig, Göttingen, and Bamberg, in 1889 (June 10 to August 24, both days inclusive). During the whole of this period there were secured over 800 observations (involving 4 pointings each) in each hemisphere, and there are only six nights during the whole period on which no observations were secured at one or more of the observatories. The combined efforts of many astronomers, and the generous co-operation of the directors of many observatories have made it possible to determine places of the comparison stars so exactly that the absolute path of a planet has (for the first time in the history of astronomy) been followed over nearly three complete lunations, with greater precision at every point than has the annual parallax ellipse of any fixed star whose parallax has as yet been determined.

For the *Sappho* observations the equations of condition are formed, and the whole work will be ready for press within a few months.

A small volume of observations of comets 1880-1889 (except the great comet of 1882, already published), with more accurate places of the comparison stars and final revision of all the observations, is ready for press.

Tables for facilitating the computation of "star-corrections" to mean place have been completed by Mr. Finlay on the plan which

\* The definitive determination of the Lunar Equation requires a rediscussion of the work, based on new heliocentric ephemerides of the Earth and *Victoria*; and in the computation of the former the lunar perturbations, instead of being taken from Le Verrier's tables, should be rigorously computed from the co-ordinates of the Moon.

he proposed in *Monthly Notices*, vol. I., p. 497, from declination  $0^{\circ}$  to  $75^{\circ}$  and, on a modified plan, from  $70^{\circ}$  to  $88^{\circ}$ . They are being employed in computing the check corrections for 1891, and are found to save much time. If, after further trial, this experience is confirmed, it is proposed to print the tables in the publications of the observatory.

So severe has been the pressure on the still inadequate computing force, that it has been impossible to attempt the reduction of the heliometer stellar parallax observations, the observations of the mutual distances and position-angles of *Jupiter's* satellites, the zenith telescope observations, the measures of *réseaux*, a large collection of measures of photographic plates, the reduction of occultations, as well as a valuable series of meridian observations of the Sun, Moon, and fundamental stars, made under Sir Thomas Maclear's directorate in the years 1861–1870, which should certainly be published.

Professor Kapteyn reported, under date 1892 June 12, that the last plate of the Southern Photographic *Durchmusterung* had been measured; and he now informs me that the first sheets of the Catalogue will be ready for press in February. An apparatus, designed by H.M. Astronomer, for engraving the maps of the *Durchmusterung* has been received from Messrs. Troughton and Simms.

The field work of the geodetic survey was completed on September 30, and Major Morris and his party are now engaged at the observatory in completing the reductions. The whole of the observed angles are completely corrected for run and level, and the definitive lengths of the three base-lines (Natal, Port Elizabeth, and Kimberley) have been deduced. A preliminary computation of the whole triangulation has been made, and a mean fundamental origin in latitude, longitude, and azimuth determined. The small corrections to the angles have also been computed, which are necessary to equalise the length of any of the four base-lines\* (computed from any other base through the triangulation in any direction), with its measured length. The final portion of the computations is now in progress, viz., the computation of the small final corrections so necessary to complete the harmony of the gridiron chains of triangles at their points of junction.

Major Morris rejoins his corps on completion of this work, after ten years' service in South Africa, rendered conspicuous by the energy, tact, and ability which he has devoted to the work of the survey, and the success with which he has overcome the many difficulties which beset such a work in a country where the scarcity of water and difficulties of transport and supply are so great.

\* The fourth base-line is that measured by Maclear (in Zwartland), the observed and computed lengths of which have been found to agree very harmoniously with the modern work.

*Cambridge Observatory.*

During the year the work has progressed on the same lines as in recent years.

The reductions of the observations are nearly completed up to the end of this year, and the arduous task of reduction to epoch for the zone stars, and arrangement of each individual result in order of right ascension, has been accomplished for nearly the first twenty hours, embracing about 33,000 places of small stars. The smaller catalogue, which will give the place of each star from the mean of all the observations, has made some progress, but cannot be taken up vigorously until the larger be completed.

The work with the transit circle has been chiefly directed to the observation of stars which had been overlooked in the preparation of the observing catalogues, or had been imperfectly observed, and to the observation of stars which had been compared with comets.

Several requests for accurate places of stars contained in the zone assigned to this observatory have been promptly met.

The Northumberland Equatoreal has been got into much better working order. The woodwork of the roof was much decayed, and has been replaced by sound material; so that the dome now revolves freely; the driving clock was put into the hands of a competent workman, and now carries the instrument round with comparative regularity. Under these improved conditions the telescope has been used much more frequently than during previous years. Preparation was made for observing the eclipse of the Moon on May 11, but clouds prevented observation.

The weather was very unfavourable in November—we only got five nights with Holmes' Comet. In these we obtained thirty-three comparisons with adjacent stars, using the square-bar micrometer. The places of some of the stars have been observed with the transit circle.

*The Newall Telescope, Cambridge Observatory.*

The Newall telescope (25 inches aperture) has been used for observation on 122 nights in the course of the year 1892.

Some difficulty was experienced in the final adjustment of the instrument, and this was traced to the obliquity of the line of collimation to the declination axis. Alterations have been made, which have so far reduced the error that further trouble has not arisen.

The new clockwork and gearing, constructed by Sir Howard Grubb, has just reached Cambridge (1893 January 2); and only the old inefficient clockwork has been available hitherto, so that observations involving the use of clockwork have been made at great disadvantage.

Under these circumstances some time has been devoted to the observation of the following planets :—*Saturn, Jupiter, Mars, Venus, Uranus, Neptune*, and drawings have been made on several occasions.

Attempts have been made several times to see Barnard's satellite of *Jupiter*. Twice a faint object was suspected near the place indicated in Marth's ephemeris, but never with such certainty as to warrant a statement that the satellite had been seen.

[Note on February 10. The satellite has since been seen with certainty twice.]

A drawing (date, April 29) of Comet  $\alpha$  1892 (Swift) shows rifts in the tail, such as the photographs of Russell, Barnard, and Wolf record. It may be remarked that the drawing was made some time before receipt of the photographic results.

The work of the year has necessarily been mainly of a preparatory nature, which, with the exception of two branches need not be specified.

Some preliminary visual photometer work has been attempted. The variation in brightness of *Nova Aurigæ* has been followed, both in the earlier and in the later appearance. A wedge photometer, having a wedge interval of about 1 inch per magnitude, is being calibrated, with a view to its application to the photometry of faint stars; it is found that the wedge is incapable of extinguishing a 10th magnitude star at its thickest end and a 15th magnitude star at its thinnest end, when the full aperture of the objective is used. Some of the regions chosen by the American committee on standards of stellar magnitude have been investigated, and this work is being continued.

Through the kindness of Mr. Lockyer two objective prisms of  $10\frac{1}{2}$ -inch aperture and  $7\frac{1}{2}$  degrees angle were put at our disposal by the Science and Art Department, South Kensington. These were mounted with a rigid framework in front of the object glass, and between August 15 and November 19, on which day the driving-screw of the Equatoreal was dismantled and sent to Dublin, eighty photographs of bright star spectra were taken, and though perhaps only sixteen of these are of use for measurement, the preliminary difficulties are in the main surmounted. With a single prism the photographed spectra are 2 inches long between F and H; and the spectrum of *Vega* was photographed with an exposure of nine minutes, and shows the hydrogen lines up to  $\zeta$  (Huggins' notation), though the more refrangible lines are diffuse; the length of the spectrum from F to  $\zeta$  is a little greater than 3 inches.

#### *Dunsink Observatory.*

There have been considerable changes at this observatory during the year which has just elapsed. On February 20 Sir Robert Ball, then Royal Astronomer of Ireland, was appointed to succeed the late Professor Adams as Lowndean Professor of Astronomy

and Geometry in the University of Cambridge. The vacancy thus caused in the directorship of the Dunsink Observatory was not filled up till October 22, when Dr. Arthur A. Rambaut, who had been assistant to Sir Robert Ball for the last ten years, was elected to the post. Dr. Rambaut, shortly after his appointment, nominated as his assistant Mr. Arthur E. Lyster, of Trinity College, Dublin.

The 15-inch Roberts reflector has been employed during the year for the purpose of obtaining stellar photographs, principally with a view to the determination of parallax. During the year 201 photographs have been obtained, representing 443 exposures, varying from  $30^m$  to a few seconds in length. Exposures exceeding  $30^m$  are never attempted at this observatory on account of the irregularities of the driving-clock, which entail an uninterrupted watch exceedingly difficult to sustain. The width of the shutter-opening, too, so little exceeds that of the main telescope and pilot together that, except near the pole, it is necessary to interrupt the exposure every fifteen or twenty minutes in order to turn round the dome.

Amongst the plates obtained are included fourteen photographs of the new star in *Auriga*, taken shortly after its first appearance in February, March, and April, and nine photographs in August, September, and October, on the renewal of the star's brightness taking place. As these observations are separated by an interval of six months, and as the star was during each period near one of the apses of its parallactic ellipse, it is hoped that the photographs may serve for a determination of the star's distance. The examination and measurement of the plates have, however, not yet been completed, being delayed by the interruptions consequent on the changes in the observatory staff.

In July and August fifteen photographs of the planet *Mars* were taken, with the view of determining its position with regard to the stars in its neighbourhood. In these photographs a small occulting shutter was used, similar to the shutter described on p. 197 of Dr. Joly's paper, "On Shutters for use in Stellar Photography," in vol. vii. pt. 3 of the *Scientific Proceedings of the Royal Dublin Society*, of which a short notice was published in *Nature* 1891 December 17, p. 167.

With this shutter it is possible to occult any selected object for any desired fraction of the exposure given to the rest of the plate. The shutter is manipulated by means of an electric key from the eye-end of the telescope. In this case the plate was exposed for  $10^m$ , while the planet's image was allowed to fall on the plate for only  $2^s$  at the middle of the exposure. This exposure gave on the Paget prize plates a well-defined disc to the planet, while on most of the plates there are several comparison stars to be found in proximity to it, by which its position can be accurately determined.

During the year 2,576 micrometer measures of stellar photo-

graphs have been made with the Troughton & Simms microscope, presented to the observatory by the Royal Irish Academy. A large proportion of these measures refer to the photographic survey of the star-cluster  $\chi$  *Persei*, which was in progress at the date of last report. The results of this preliminary investigation are published in the *Transactions of the Royal Irish Academy*, vol. xxx. pt. iv. This memoir contains, in addition to the measures themselves, an exposition of the method of measurement, a chart of 223 of the principal stars laid down from the measures, and the formulæ of reduction which we were led to adopt.

A further examination of the correction for refraction to measures of stellar photographs by Professor Rambaut will be found in the *Astronomische Nachrichten*, No. 3125. The formulæ there given have been found to be very convenient, especially if, as has been done for this observatory, the values of the quantities  $m$ ,  $n$ ,  $\mu$ ,  $\nu$  are tabulated for every minute of hour angle.

During the lunar eclipse of May 11 thirteen photographs of the Moon were taken, showing the progress of the Earth's shadow across the disc. These photographs were exhibited at a meeting of the Royal Dublin Society, and seem to show that for short exposures ( $2^s$ ) the outline of the shadow was to a great extent modified by the nature of the surface upon which it fell, and was very difficult to define, but that with exposures of a minute or so a well-defined circular outline was obtained, although most of the detail on the surface was thereby sacrificed.

There has been no systematic work done with the meridian circle during the year. The place of Holmes' comet was determined with it on November 19, but with the exception of this and a few other observations, the work of this instrument has consisted of time determinations for the service to Dublin and the use of the observatory. There have been in all 366 observations made with this instrument.

The "South" refractor has been in occasional use for observations of *Saturn*, *Jupiter*, and *Mars* when in opposition, for observations of Holmes' Comet, and on the first Saturday of the month it has been put at the disposal of visitors to the observatory.

For the ensuing year Professor Rambaut intends to employ the Roberts reflector for stellar parallax work, as he has done for some time past, while the meridian-circle in connection with the chronograph will be devoted to the investigation of the proper motion of stars.

An account of an investigation of the absorption of heat in the Sun's atmosphere, in which Professor Rambaut has been associated with Mr. W. E. Wilson, will be found in the report of the work of Mr. Wilson's observatory during the past year.

*Glasgow Observatory.*

The operations at the Glasgow Observatory for the past year have consisted mainly in the completion of the "Second Glasgow Catalogue of 2,156 Stars for the Epoch 1890." This catalogue, which is now distributed to the leading astronomers and institutions all over the world, was undertaken with the object of ascertaining the cause of discrepancies which existed between the places of certain stars as given in the first Glasgow Catalogue and the corresponding places of Weisse's Bessel Catalogue. To this list a considerable number of new W. B. stars were added. A comparison was then instituted between the results of these observations and the corresponding places reduced from Baily's Lalande and Weisse's Bessel Catalogues, and when appearances seemed to indicate proper motion other authorities were looked up to confirm it. The results of these researches are given in the list of 192 stars of decided proper motion in the Introduction to the new catalogue. The meteorological work of the observatory has also been carried on as in former years.

*Liverpool Observatory, Bidston, Birkenhead.*

Since the appointment of the new director a very thorough examination of the transit instrument has been made, and notwithstanding its fifty years of constant service, the instrument is still adequate for the purposes in which it is engaged. In connection with a chronograph, constructed on plans supplied by the late Professor Bond, of Cambridge (Mass.), it is proposed to carry on the investigation of the parallax of some binary systems after the plan successfully adopted by Professor J. C. Kapteyn.

The Equatoreal (8 inches) has been, and in the future will continue to be, employed in the systematic observation of comets.

The self-registering meteorological instruments have continued in uninterrupted operation throughout the year, and no change is proposed in their arrangement. The discussion of the meteorological records, accumulated during the last twenty-five years, is contemplated. The digest of meteorological observations made under the superintendence of the late Mr. J. Hartnup in 1889-1891 is now in the press, and the results will shortly be sent to those who are sufficiently interested in meteorological work to apply for a copy.

*Radcliffe Observatory, Oxford.*

During the year the staff has been chiefly employed on the work of the General Catalogue of 6,350 stars for 1890, between the Equator and  $115^{\circ}$  N.P.D. There only remain 371 of these

stars which require an additional observation. The precessions and secular variations required for the formation of the catalogue have been computed, and the mean places for the different years brought up to the epoch 1890, and this part of the work is now under examination.

The Moon was observed with the transit circle at every opportunity in 1892, but the comparisons of the results with Hansen's Tables have not yet been completed. The places of the Moon observed in the year 1891, showed that the tabular error of Hansen's Tables in longitude had increased to  $19''.3$ , and the increase had been at the mean rate of  $0''.75$  per annum since the end of the year 1863.

Meridian observations of *Mars* and the selected comparison stars were secured on twenty-two nights, being every available night from 1892 June 27 to September 19. The low altitude of the planet affected the definition very considerably, and must to some extent have increased the probable error of the observations.

The zenith distance and transit reductions are completed for 1892.

With the Barclay Equatoreal the following observations have been made:—Seventeen measures of eleven double stars; estimation of the magnitude of *Nova Aurigæ* on thirty-one nights; examination of the Great Nebula in *Andromeda*, and of certain stars for apparent discrepancy of magnitude; some observations of the solar spectrum. The place of Comet *Wolf* was obtained on January 6, and Comet *Holmes* was observed on 1893 January 20.

Five occultations of stars by the eclipsed Moon were secured on May 11, but further observations were prevented by the sky becoming completely overcast.

The meteorological observations have been carried on with the usual regularity.

In the month of September, Mr. F. Bellamy was appointed as assistant at the University Observatory, and his post has been filled up by the appointment of Mr. E. McClellan.

#### *Oxford University Observatory.*

The general scope of the observatory work has been unchanged during the past year. The observations for the parallax of about thirty stars, chiefly of the second magnitude, have been at length completed. The results have been published at the expense of the University of Oxford, and have been circulated among various observatories.

The work for the International Star Chart has been prosecuted to the extent permitted by indifferent weather.

An attempt has been commenced for the determination of the parallaxes of various stars in the *Pleiades*, but the position of the group in the heavens renders the work peculiarly difficult. At all events it is to be hoped that the attempt will issue in a

X

catalogue of the coordinates of all the stars therein up to magnitude 12.

Recently a convenient observatory has been erected, contiguous to the main building, for the exclusive use of university students. This observatory is furnished with two small transit circles, three telescopes, one of which is a reflector of 15 inches aperture, a clock, and various smaller instruments, such as sextants and spectroscopes. In this way the larger instruments in the observatory proper are reserved for research, and more serviceable instruments are provided in their stead for the purposes of instruction. This building is provided with three low-pitched roofs, two of which slide the one over the other, and both of them over the fixed roof of a room provided for the purposes of professorial instruction.

After nineteen years of most able service, Mr. Plummer has taken up his appointment as Director of the Liverpool Observatory. He leaves behind him our grateful recollections of his capabilities and zeal in the past, and our confident expectations that a very useful career lies before him in the future.

#### *Temple Observatory, Rugby.*

The usual educational work has been carried on at this observatory during the past year. Mr. Highton has continued the measurement of double stars, and has completed a considerable number of measures. Some little photography has been done on the nebulae with a 15-inch mirror of 48 inches focus.

#### *Stonyhurst College Observatory.*

Some additions have recently been made to the apparatus of the large grating spectrometer, to meet the requirements of photography as applied to small parts of the Sun's disc, such as spots, faculae, and prominences. The instrument and its heliostat have been already described in the Annual Report of 1891 February. Since then, a 4-inch objective (Jones) has been employed for the solar image, in place of the 6-inch (Alvan Clark) that was originally mounted for the purpose; and the image is now enlarged by a simple concave lens placed near the principal focus of the objective. This arrangement has been found more convenient than an objective of greater focal length; the image is easily brought to a focus by the sliding motion of the enlarger, without shifting the objective, and spots of moderate size are distinctly seen on the slit-plates.

The glass reflectors are now silvered for first surface reflection. Liebig's process, as modified by Mr. Brashear, has been adopted for the purpose, and has given every satisfaction. The exposed positions of the mirrors makes the re-silvering a more frequent necessity than is desirable; but the process is simple,

and the pair of surfaces can easily be renewed in an evening, and made ready for service, if wanted, on the following morning.

The photographs of spot spectra, taken in November and December, number fifteen, all in the green-yellow region. Their evidence, so far, is not conclusive, either for or against real widening of any of the solar lines over spots. But some observers find the same lines, about six in all, widened on all the plates that contain them.

About twenty plates have been exposed to the H K region, with the slit crossing the solar image over areas of faculæ. These show the reversals of H and K, and the reversals are always double, as observed by M. Deslandres and by Professor Hale. On some of the plates the reversals are traceable all along the lines, showing only intensification at the positions of the faculæ; and on three plates exposed to the Sun as a star (*i.e.* without an image on the slit) the same reversals are clearly though not strongly marked. These plates, therefore, confirm the observation of M. Deslandres recorded in the *Comptes Rendus* 1892 July 25.

The drawings of the solar spots, and the measures of the chromosphere and prominences, have been carried on as usual; but the latter observations have been made only on days which showed a fair probability of completing the measures all round the disc without much interruption. Sixty-four complete measures have been made in this way, and the spots and faculæ have been sketched on 160 days, including full drawings and outlines.

The examination of the solar drawings for the year of least activity, 1889, has been greatly interrupted during the course of the past twelve months, but it is now nearly complete. We find twenty-seven separate groups of spots for that year, and 121 groups of faculæ. Of the latter, those which were unassociated with spots were generally small and short-lived, but in number and position, as set out upon the chart, they show two remarkable polar belts in latitudes  $72^\circ$  north and south. The southern belt is much the more pronounced, and in general both spots and faculæ are stronger in number and extent in the southern hemisphere. Six clear cases have been found, in the same year, of small bright faculæ preceding the formation of a spot. And we have apparently conclusive evidence, from seventeen groups of faculæ in the zone between  $27^\circ$  north and south of the Equator, that the rotation-periods of faculæ vary with their latitudes, in strict conformity with Carrington's law for the spots. All these groups have been observed on more than one passage across the visible surface of the sun, and some during as many as four or five rotations.

The night work with the 8-inch Equatoreal has been, almost exclusively, the photography of stellar spectra. The collection of plates, from 1891 September, is a small one. About 180 photographs of 45 stars are available for wave-length measure-

ments, exclusive of many others of a purely experimental purpose. This will probably be the concluding list of operations with the 8-in objective. The new one of 15 inches, purchased with the fund raised to the memory of the late Father Perry, is expected to be in position for a new series of stellar spectra early in March.

*Dr. Common's Observatory, Ealing.*

During the past year a new 5-foot mirror has been made for the telescope, the disc of glass being that supplied by the Saint-Gobain Glass Co. to replace the first disc.

Very little observational work has been done. The fifth satellite of *Jupiter* has been seen on several occasions. The work on plane mirrors has been carried on, and the method of paper polishing recommended by Foucault tried with an encouraging amount of success.

*Mr. Crossley's Observatory, Bermerside, Halifax.*

The astronomical work of this observatory has been chiefly the measurement of double stars, the observation of the phenomena of the satellites of *Jupiter* and *Saturn*, the occultation of stars by the Moon, and transits of clock stars for time. The usual meteorological observations at 9 A.M. and 3 P.M. have also been made, and reports sent to the Registrar-General, Mr. Symons, and the local sanitary department. As Mr. Crossley has withdrawn from active astronomical work, he has decided to dispose of the 3-foot reflector and dome.

*Wolsingham Observatory (Rev. T. E. Espin's).*

The usual spectroscopic zone-work was somewhat interrupted in the spring by the attention given to the *Nova Aurigæ*. In zones  $+55^{\circ}$  and  $+56^{\circ}$ , 116 new third-type stars were, however, detected. Amongst these one star (D.M.  $+55^{\circ}$ . 1870) was suspected of variability; but Professor Pickering has found no variation from the Harvard photographs. In the autumn it was determined that the telescope should be entirely devoted to the revision of double stars in connection with the forthcoming edition of *Celestial Objects for Common Telescopes*, but it was not till October 1 that sufficient practice had been made to warrant the commencement of actual measurements. Between this and the end of the year 847 measures were made, observations being often carried on for 12 hours consecutively, and on one favourable night for  $13\frac{1}{2}$  hours, on account of the urgency of the work. Moreover, during the measurements new companions were in many cases detected, closer than those already known. Thus  $\Sigma$  306 has three comites

nearer than the one measured by Dembowski; while  $\Sigma$  994, H V. 66,  $\beta$  *Camelopardi*, were found to be more closely double. Generally the new comites are difficult objects, and are only measured with much difficulty.

The daily readings of the meteorological instruments have been continued during the year.

*Dr. Huggins' Observatory, Upper Tulse Hill, S.W.*

The work of this observatory during last spring was chiefly devoted to observation—both visual and photographic—of *Nova Aurigæ*. The results have been published in the Royal Society's Proceedings.

During the summer and autumn alterations were in progress in the equipment of the observatory; these have now been completed, and work has been resumed.

*Rousdon Observatory, Lyme Regis (Mr. C. E. Peek's).*

Observations of "long-period variable stars" have been continued during 1892. The year has been, on the whole, favourable for astronomical work, 166 nights having been available for observations: 502 determinations of magnitudes were obtained, this being considerably in excess of any of the previous six years' work. The working list includes twenty-four objects, chiefly long-period circumpolar variables, with a few, less-favourably situated, but specially interesting objects. Among the latter is *Nova Aurigæ*, which has been been examined with great attention. The nebulous and ill-defined appearance of this variable has been noticed by several observers, and has drawn special attention to the unusual characteristics of the images of many of the variables as compared with ordinary non-variable stars. This peculiarity has also been observed here with regard to several other stars for several years past.

The usual observations of clock stars have been taken.

Instrument in use, 6.4-inch equatorial refractor. Powers 34, 80, and 132.

*Dr. Isaac Roberts's Observatory, Crowborough Hill, Sussex.*

Photographs of stars, planets, nebulae, and clusters of stars have been taken, as frequently as practicable, during the year ending 1892 December 31, but the number of nights sufficiently clear for long exposures of the plates has, I think, been below the average that might be expected in this locality. Moonlight also diminishes largely the number of nights that would, in its absence, be suitable for photographic work.

One hundred and twenty-two photographs, with exposures from 30 minutes to 4 hours, were obtained during the year, and also many others with shorter exposures. Of the plates with

long exposures 18 were taken in March, 26 in April, 14 in October, and 15 in December.

Ten plates of the eclipse of the Moon on May 11 were taken, with exposures from 4 seconds to 10 minutes each, and upon them the phases are well recorded.

Following is a list of the regions in the sky which have been photographed with long exposures during the year, and the plates are available for reference when required. Those marked \* have been enlarged and presented to the Society, and I am engaged in preparing for publication about fifty selected photographs, with the necessary descriptive matter to accompany them, so as to make them available, at a nominal price, for the use of astronomers.

The coordinates given are those for about the centre of the plates, each of which covers  $2^\circ$  by  $2^\circ$  of the sky.

	R. A. h m	Decl. ° ' "	Expos. m
Neb. near $\beta$ Andromedæ	1 3½	N. 35 10	60
*Comet Holmes	0 43	„ 37 24	75 and 30
Neb. $\text{H I. 151}$ Piscium	1 19	„ 9 0	90
Cl. 103 M. Cassiopeïæ	1 26	„ 60 9	60
Neb. $\text{H I. 100}$ and $\text{II. 4}$ Ceti	1 27	S. 7 30	60
Cl. 74 M. Piscium	1 31	N. 15 15	90
Cl. $\text{H VI. 31}$ Cassiopeïæ	1 38½	„ 60 43	60
Neb. Trianguli	2 31	„ 29 41	60
Cl. 34 M. Persei	2 35	„ 42 20	60
Neb. 77 M. Ceti	2 37	S. 0 27	90
Cl. $\text{H VI. 25}$ Persei	3 7½	N. 46 51	54
Cl. Camelopardi	3 56½	„ 69 30	60
Neb. Star H. IV. Tauri	4 3	„ 30 30	140
Plan. Neb. $\text{H IV. Eridani}$	4 10	S. 13 2	60
Neb. $\text{H I. 217}$ Aurigæ	4 23	N. 35 3	90
Cl. 38 M. Aurigæ	5 21½	„ 35 44	60
*Nova Aurigæ	5 24	„ 30 23	5 to 3 <sup>h</sup>
*Crab Neb. 1 M. Tauri	5 29	„ 21 57	... 3 <sup>h</sup>
Cl. 35 M. Geminorum	6 2	„ 24 21	55
Sirius	6 40	S. 16 34	4 to 2 <sup>h</sup>
Neb. $\text{H I. 163}$ Sextantis	10 0	„ 7 12	60
Regulus	10 2	N. 12 29	90
Neb. 99 M. Virginis	12 13	„ 13 0	90
Neb. 95 M. Leonis	10 40	„ 12 18	90
Neb. $\text{H I. 13}$ Leonis	11 0	„ 0 32	90

	R. A. h m	Decl. ° ' "	Expos. m
Neb. 66 M. Leonis	11 14	N. 13 40	90 and 4 <sup>h</sup>
Search for Planet beyond } Neptune from	11 24	„ 0 0	90
to	12 12	„ 6 0	90
Neb. 98 M. Virginis	12 8	„ 15 29	90
Neb. 61 M. Virginis	12 16	„ 5 3	90
Neb. 84 and 86 M. Virginis	12 20	„ 13 30	90
Neb. 85 M. Comæ Berenicis	12 20	„ 18 46	90
Neb. 41 M. Virginis	12 24	„ 8 35	90
Neb. 88 M. Virginis	12 26½	„ 15 0	90
Neb. 87, 89, and 90 M. Virginis	12 28½	„ 13 26	... 4 <sup>h</sup>
Neb. 54 M. Virginis	12 36	„ 12 16	90
Neb. 94 M. Canum Venaticum	12 46	„ 41 42	90
Glob. Cl. 53 M. Comæ Berenicis	13 7	„ 18 44	60
Neb. 63 M. Canum Venaticum	13 11	„ 42 35	50
Neb. H I. 34 Virginis	13 32	„ 9 26	90
Cl. 3 M. Canum Venaticum	13 37	„ 28 55	60
Neb. 101 M. Ursæ Majoris	13 59½	„ 54 52	90 and 200
Neb. H I. 215 Draconis	15 3½	„ 56 10	90
Cl. 5 M. Lyræ	15 13	„ 2 28	90
Cl. 12 M. Ophiuchi	16 41½	S. 1 45	60, 105, and 2 <sup>h</sup>
Cl. 14 M. Ophiuchi	17 32	„ 3 11	90
Cl. 26 M. Cyp. Sobieskii	18 39	„ 9 30	90
Cl. H I. 47 Aquilæ	18 47	„ 8 50	60 and 120
Cl. h 2024 Aquilæ	18 49	N. 10 13	60
Cl. 56 M. Lyræ	19 12½	„ 30 0	... 3 <sup>h</sup>
Cl. 52 M. Cephei	23 19	„ 61 1	60
Cl. 71 M. Sagittæ	19 49	„ 18 30	90
Cl. H I. 103 Delphini	20 29	„ 7 3	60 and 3 <sup>h</sup>
Neb. H V. 15 Cygni	20 46½	„ 30 15	... 4½ <sup>h</sup>
Neb. H V. 14 Cygni	20 52	„ 31 4	120
Neb. H I. 192 Cephei	20 57	„ 54 9	90
Neb. H I. 53 Pegasi	22 32	„ 33 52	219
*Neb. H I. 55 Pegasi	23 0	„ 11 46	... 4 <sup>h</sup>
*Cl. H VI. 30 Cassiopeiæ	23 52	„ 56 8	60 and 90

*Mr. W. E. Wilson's Observatory, Streete, Co. Westmeath.*

The remounting of the 2-foot reflector by Sir H. Grubb was completed about February last. A considerable number of photographs of stars have been taken, principally with the view of getting the telescope in final adjustment.

Some photographs were taken in the autumn of *Jupiter* and his satellites with the photographic photometer in order to determine the relative albedo of the planet and his moons. The results will shortly be laid before the Society.

The mirror was sent to Sir H. Grubb in November in order to make it a better fit in its cell.

A paper was read by myself and Professor Rambaut before the Royal Irish Academy in May on "The Absorption of Heat in the Solar Atmosphere." A copy of this has been sent to the library of the Society. The large siderostat kindly lent by the Royal Society to carry on experiments on solar radiation has arrived, and will be erected this coming spring.

*Hong Kong Observatory.*

During the past year the time-ball was dropped daily at 1 P.M. The transit observations were made with a new chronograph by Sir H. Grubb, of Dublin, which works exceedingly well. Some observations of eclipses and shooting stars were also made.

Absolute magnetic observations were made monthly.

Local, continuous, and hourly meteorological observations were made the same as in previous years. Reports were received from about forty stations on shore, a number of which were inspected during the year. Over 500 extracts of log-books of ships having encountered bad weather were copied. Daily weather-maps for the years 1888 to 1892 inclusive are ready, and are being used in the investigation of orbits of typhoons in those years. Daily weather reports and telegraphic storm-warnings were issued as usual. A number of instruments were verified.

Three years' hourly readings of tides from trace on Sir W. Thomson's automatic tide-gauge were finished, and the first two harmonically analysed by Mr. Roberts, in London. These records have since been discontinued.

The eighth annual volume was issued last spring, and the ninth volume is nearly ready for press.

Lectures on spherical and practical astronomy were delivered to the staff.

*The Madras Observatory.*

During 1892, as for several years past, observations other than those required for the efficient maintenance of the time service have been entirely subordinated to the work of publication. During the year two volumes of the *Madras Meridian Circle Observations* and one volume of *Meteorological Results* have been published, and at the close of the year two other volumes were well advanced. The *Meridian Circle Observations* are now in type to the close of 1878, but as the observations were continued till 1887, it will probably be nearly two years more before the final catalogue can be issued. In the early part of the year the Officiating Government Astronomer made a series of comparative observations at Madras, Kotagiri, on the Nilgiris, and Kodaikanal, on the Palani Hills (7,500 feet above sea level), with the object of testing their relative merits as sites for the proposed new observatory. The general result of the observations was that Kodaikanal was far superior to either of the other two—a result since confirmed by meteorological observations.

The future of the observatory as to position, equipment, and staff is still undecided, but there seems to be good reason to hope that something will be done before long to put matters on a more satisfactory footing.

*Melbourne Observatory.*

The astronomical work of the Melbourne Observatory during 1892 has consisted chiefly of meridian observations and astrographic operations. Very little extra-meridional work has been done, either with the great telescope or the smaller equatorials, beyond occasional planet or comet observations.

As regards the meridian work, the places of 3,181 stars in R.A. and 1,861 in N.P.D. have been obtained, and a list of 913 guiding-stars, for use at the Tacubaya Observatory in connection with the astrographic operations, was completed in March last and forwarded to its destination.

Considerable progress has been made with the astrographic work during the year, although it has been much hindered by somewhat unusually cloudy weather in Melbourne during the spring and summer. It is found that photographs, to fulfil the necessary conditions, cannot be obtained unless the sky is absolutely clear and free from moonlight; the slightest trace of the latter diminishes the photographic magnitudes of star images on the plates in a very marked manner. Only those nights, therefore, are used which are quite clear, and on which there is no moon. The number of Catalogue plates obtained up to date is 548. No work has yet been done with Chart plates.

Owing to large retrenchments in colonial expenditure, the

annual grant to the observatory has been seriously reduced since June, and the staff has been permanently reduced by the retirement, on pension, of the two senior assistants, Messrs. White and Moerlin. Mr. Baracchi, the third assistant, has taken up the duties of these two officers as far as possible, and, although the work of the establishment has necessarily to be considerably curtailed, it will affect the routine operations chiefly. The meridian and astrographic work will go on as usual, as will the magnetographic and meteorological work; the latter, however, being somewhat reduced in its less important details.

Regular work with the great telescope must be given up for the present, and little time can be given to any but the most important extra-meridian observations.

The routine work of the observatory, which includes meteorological and magnetic observations, distribution of time by signals and telegraph, rating chronometers, testing barometers, thermometers, linear measures, &c., and tidal observations, has been carried out during the year as usual.

#### *Natal Observatory, Durban.*

The principal work of the past year has been the observation of the opposition of *Mars* during July and August, and, as the weather was fairly favourable, it is to be regretted that the observatory did not possess the requisite instruments necessary for carrying out the observations according to the schemes suggested by either Professor Newcomb or Mr. Stone.

With the view of supplying some data in the event of unfavourable weather at the other southern observatories, care was taken to obtain the best results that could be obtained with the limited means at the observatory.

The meridian observations were made with the transit instrument firmly clamped in one position the whole evening, the difference between the declination of *Mars* and all available stars being measured with the micrometer. The field of view of the micrometer is rather more than one degree, the instrument being provided with double slipping pieces, and all stars brighter than  $7\frac{1}{2}$  mag. which transited within half an hour of the planet were observed, usually five to eight each evening.

As a rule, a bisection was made as the star crossed each of seven vertical wires ( $20^s$  apart), whilst the planet was observed at the same wires, north and south limbs being taken alternately at each wire. Generally, each star was observed on seven or eight successive nights. In all observations were obtained on thirty-eight nights.

Observations for diurnal parallax were made with the equatorial, which was kept firmly clamped in declination, whilst

differences in right ascension were obtained by the observed transit over seven wires of the planet and selected star. In all sixty-two sets of morning and evening observations were obtained.

Further progress is being steadily made in preparing for the press the *Memoirs On the Reduction of the Lunar Observations and The Theory of the Perturbations produced by the Planets*; and though there is much delay from the heavy pressure of official duties, and especially the routine work consequent on the absence of any qualified assistance, it will not be long before the last pages of one, if not of both, papers are written out ready for publication.

### *Sydney Observatory.*

At Sydney Observatory the year 1892 has been cloudy and wet, and, like its predecessor, generally unfavourable for astronomical observations. From May 10 to December 22 Mr. Lenehan was away on sick leave, and Mr. Sellors had to take his place, which has seriously reduced the number of measures of double stars. Owing mainly to this it was found impossible to take special observations of *Mars* during opposition, and the weather was so unfavourable that it was impossible to get good views of the features of the planet except on two nights when the conditions were fairly good, but even then nothing was seen of the so-called "canals."

The difference of longitude between Sydney and Brisbane has been determined and found to be in very satisfactory agreement with two previous determinations. The observations and telegraphic comparisons were made from February 24 to March 1. In connection with this, Mr. R. G. McDawall's personal equation was determined during three nights.

With the transit circle 1,001 transits in R.A. have been taken, comprising 597 stars in R.A. only, and 404 in R.A. and N.P.D. These belong to the photographic zone.

Azimuth has been determined 128 times; Collimation, 272; Level, 341; Nadir, 351.

Comets Swift and Biela were observed, the former on three and the latter on six nights.

The computations of transit work have been completed up to the end of 1892, and recomputations of previous transit observations brought up to the end of 1890. The results of transit observations, with catalogues for 1879 and 1880, are printed, and 1881 is in progress. A full account of the New South Wales transit of *Venus* observations in 1874, illustrated by forty-one coloured diagrams, photographs, &c., has been published.

Meteorological results for the years 1880 to 1884 and 1890 have been printed. Rain and river results for 1890 have been

printed and published, and those for 1891 have been printed but not yet distributed.

A new edition of *Physical Geography and Climate* has been published; also some pamphlets, making in all 1,600 pages. A fully-illustrated description of the Star Camera has also been published.

A number of bromide enlargements of stellar and lunar photographs have been made, and with such good results that it is obvious that many astronomical photographs require to be treated in this way to see them to advantage. Some cheap printing process is wanted for multiplying these enlargements, which are real aids to the study of photographs.

Several photographs of Swift's Comet, one of which was presented to the Royal Astronomical Society, were taken in March, with a result that was not expected. The comet was shown by them to have eight ribbon-like rays, which were all invisible with the large equatoreal, even when the camera had revealed their existence. Some photographs have been taken of Brooks' Comet, which show the tail, but no rays like those of Swift's Comet. Four photographs of the latter show the rays. Six photographs of the Moon during the total eclipse of November 5 were taken.

During the year ninety-three nights were partially or wholly good for star-catalogue plates, and thirty-seven nights cleared enough to get a test object taken, and then clouded over. 465 star-catalogue plates were taken, 136 of test objects, 10 of comets, and 12 of *Mars*, making a total of 623. The year thus appears to have been better than 1891, during which only fifty-two nights were partially or wholly good. Three *réseaux* have been obtained from M. Gautier of Paris, but only one of these was free from pin-holes. The actual measurement of the plates has not yet been commenced.

Some experiments are in progress as to the value of photography in determining a comet's position relative to stars. Five minutes' exposure gives a good image of Brooks' Comet, and images of stars slightly elongated in the direction of the comet's motion, but capable of exact measurement.

The weather chart service has been maintained and two editions published daily. Close attention has been given to the investigation of weather conditions, and some results have been published, especially a study of the anticyclonic systems which pass over Australia and rule our weather.

*Mr. Tebbutt's Observatory, The Peninsula, Windsor,  
New South Wales.*

The year 1892 was characterised by a large proportion of cloudy nights, and yet much excellent work was done. The local time was determined on 159 nights, the number of stars observed

for this purpose with a declination not exceeding  $40^\circ$  being 908. The number of separate determinations for the level, collimation and azimuth errors of the transit instrument were 378, 43 and 162 respectively. There has been only one adjustment of the instrument, and that for level, during the year. The errors have been subject to small fluctuations only, and the rate of the standard sidereal chronometer has been satisfactory. The following is a statement of the extra-meridian work with the 8-inch and  $4\frac{1}{2}$ -inch equatoreals.

Occultations of stars by the Moon were observed, comprising twenty-six disappearances at the dark and six at the bright limb, and six reappearances at the dark and seven at the bright limb. The occulted stars have, with the exception of one, been all identified, and they are nearly all stars whose positions have been well determined. I have again to acknowledge the co-operation of Mr. R. T. A. Innes, F.R.A.S., of Sydney, who has kindly sent me monthly his prediction calculations of the occultations of *Nautical Almanac* stars.

The following double stars were measured with the 8-inch telescope:— $\rho$  *Eridani*,  $h$  4373,  $\alpha$  *Crucis*,  $\gamma$  *Centauri*,  $\gamma$  *Virginis*,  $\beta$  *Muscae*,  $h$  4634,  $\alpha$  *Centauri*,  $\pi$  *Lupi*, *Lacaille* 6477,  $\rho$  *Ophiuchi*, 36 *Ophiuchi*, *Brisbane* 6556, and  $\gamma$  *Coronae Australis*.

Twenty filar-micrometer comparisons of *Mars* and  $\iota$  *Aquarii* were obtained with the 8-inch equatoreal on November 4. The objects were not seen till after the conjunction in R.A., but it was quite obvious that no occultation could have taken place at the Observatory. The star forms one of Herr Berberich's list in No. 3073 of the *Astronomische Nachrichten*.

Swift's Comet I. 1892 was observed on March 10, 21, 22, 26; April 9, 10, 11, 12, 13, 14, 15, 16, 22, 23, 30; May 1, 2; the number of comparisons being 246, and that of the comparison stars 29. Winnecke's periodical Comet was picked up on June 12, but as it was then in pretty high north declination, no observations were attempted. After its conjunction with the Sun, however, it was observed on July 17, 19, 20, 21, 22, 23, 24, 27, 28, 29; August 2, 3, 15, 23, 25, 26, 27; September 16, 17, 18, 20, 22, 26, 27. 248 comparisons were made, in which twenty-nine comparison stars were employed. Holmes' Comet was observed on November 13, 15, 18, 19, 20, 22, 23, 24. The observations comprise fifty comparisons and five comparison stars. Brooks' Comet of August 28 was observed on November 28, 29; December 8, 9, 12, 13, 14, 15, 20, 21, 23, 24, 28, 29, the number of comparisons being 177 and that of the comparison stars 23. Observations were continued after the close of the year, but these will properly be accounted for in the Report for 1893. Tempel's Comet II. 1867 was searched for between R.A.  $17^h 30^m$  and  $18^h 50^m$ , and the parallels of twenty-five and thirty-two degrees south declination on June 19. Although the sky was brilliantly clear and the Moon absent no trace of the Comet could be found.

A few observations of the phenomena of *Jupiter's* satellites were made, and a few estimations were also obtained of the magnitudes of  $\eta$  *Argûs* and *R Carinæ*. The meteorological observations have been carried on as usual, and the Abstracts of Results for 1886, 1887, 1888, 1889, and 1890 widely distributed. The whole work of observation, both in the astronomical and in the meteorological departments, and the greater portion of the reductions, have been done by the proprietor himself. All the instruments remain in good order, and the library has been greatly enriched by valuable donations.